



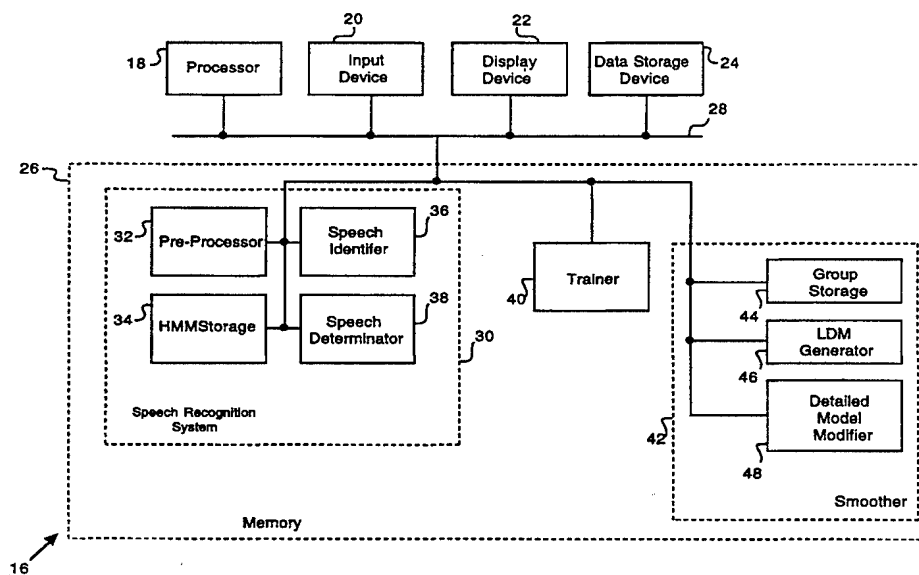
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| (51) International Patent Classification ⁶ : G10L 5/06 | A3 | (11) International Publication Number: WO 96/23298 (43) International Publication Date: 1 August 1996 (01.08.96) |
| (21) International Application Number: PCT/US96/01002 (22) International Filing Date: 23 January 1996 (23.01.96) (30) Priority Data: 08/378,963 26 January 1995 (26.01.95) US (71) Applicant: APPLE COMPUTER, INC. [US/US]; One Infinite Loop, Cupertino, CA 95014 (US). (72) Inventors: HON, Hsiao-Wuen; 19445 Dorchester Drive, Saratoga, CA 95070 (US). YUAN, Bao-Sheng; Blk 466 Jurong West #11-524, Street 41, Singapore 2264 (SG). (74) Agents: SUEOKA, Greg, T.; Fenwick & West, Suite 600, Two Palo Alto Square, Palo Alto, CA 94306 (US) et al. | | (81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AZ, BY, KG, KZ, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> (88) Date of publication of the international search report: 19 December 1996 (19.12.96) |

(54) Title: SYSTEM AND METHOD FOR GENERATING AND USING CONTEXT DEPENDENT SUB-SYLLABLE MODELS TO RECOGNIZE A TONAL LANGUAGE

(57) Abstract

A speech recognition system for Mandarin Chinese comprises a pre-processor (32), HMM storage (34), speech identifier (36), and speech determinator (38). The speech identifier includes pseudo initials for representing glottal stops that precede syllables of lone finals. The HMM storage stores context dependent models of the initials, finals, and pseudo initials that make the syllables of Mandarin Chinese speech. The models may be dependent on associated initials or finals and on the tone of the syllable. The speech determinator joins the initials and finals and pseudo initials and finals according to the syllables of the speech identifier. The speech determinator then compares input signals of syllables to the joined models to determine the phonetic structure of the syllable and the tone of the syllable. The system also includes a smoother (42) for smoothing models to make recognitions more robust. The smoother comprises an LDM generator (46) and a detailed model modifier (48). The LDM generator generates less detailed models from the detailed models, and the detailed model modifier smoothes the models with the less detailed models. A method for recognizing Mandarin Chinese speech includes the steps of arranging context dependent, sub-syllable models; comparing an input signal to the arranged models; and selecting the arrangement of models that best matches the input signal to recognize the phonetic structure and tone of the input signal.



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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 96/01002

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G10L5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G10L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|--|-----------------------|
| X | INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH AND SIGNAL PROCESSING 1993, vol. 2, 27 - 30 April 1993, MINNEAPOLIS, MN, US, pages 227-230, XP000427767 LIN ET AL.: "A new framework for recognition of Mandarin syllables with tones using sub-syllabic units" see paragraph 3 --- -/-- | 1 |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

21 June 1996

Date of mailing of the international search report

30. 10. 96

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 96/01002

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|---|-----------------------|
| A | <p>PROCEEDINGS OF INTERNATIONAL COMPUTER SYMPOSIUM 1994, vol. 2, 12 - 15 December 1994, HSINCHU, TW, pages 1140-1145, XP000573580 WANG ET AL.: "An intinial study on large-vocabulary contiuous Mandarin speech recognition with limited training data based on sub-syllabic models" see paragraph 2</p> <p style="text-align: center;">---</p> | 1,21,29 |
| A | <p>US 5 220 639 A (LEE) 15 June 1993 see column 3, line 53 - column 5, line 36</p> <p style="text-align: center;">---</p> | 1,21,29 |
| A | <p>INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH AND SIGNAL PROCESSING 1994, vol. 1, 19 - 22 April 1994, ADELAIDE, SA, AU, pages 545-548, XP002006388 HON ET AL.: "Towards large vocabulary Mandarin Chinese speech recognition" see paragraph 4</p> <p style="text-align: center;">---</p> | 1,21,29 |
| A | <p>CSELT TECHNICAL REPORT ON EUROSPEECH 1991, vol. 20, no. 1, 1 March 1992, IT, pages 43-47, XP000314309 GIACHIN ET AL.: "WORD JUNCTURE MODELING USING INTER-WORD CONTEXT-DEPENDENT PHONE-LIKE UNITS" see paragraph 2</p> <p style="text-align: center;">-----</p> | 1,21,29 |

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 96/ 01002

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. claims 1-14, 21-27, 29-35
2. claims 15-20, 28, 36

For further information see Form PCT/ISA/206 sent to you on 27.06.96

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1 - 14, 21 - 27, 29 - 35

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

Information on patent family members

PLT/US 96/01002

Form PCT/ISA/210 (patent family annex) (July 1992)